

ANALYSIS OF NUTRITIONAL QUALITY TRAITS IN AN ANDEAN RECOMBINANT INBRED LINE POPULATION.

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Introduction:

Legumes provide essential micronutrients that are found only in low amounts in the cereals or root crops (Wang et al., 2003). An ongoing project at CIAT has shown that bean seeds are variable in the amount of minerals (iron, zinc and other elements), vitamins and sulfur amino acids that they contain and that these traits are likely to be inherited quantitatively. In this study we analyzed iron and zinc content in an Andean recombinant inbred line (RIL) population derived from a cross between G21242, a Colombian cream mottled climbing bean with high seed iron/zinc content and G21078, an Argentinean cream seeded climbing bean with low seed iron/zinc content.

Materials and Methods:

The population was analyzed over two locations in Colombia (Popayán and Darién) with 100 RILs planted in the first site and a subset of 83 RILs planted in the second site. A lattice design was used for the first trial (with 3 repetitions) and a randomized complete block design was used for the second trial (with 2 repetitions). Both experiments were planted with trellis supports since the population is predominantly made up of climbing bean genotypes and agronomic management consisted in recommended practices. In both seasons, plots were bulk harvested and grain was combined across repetitions before sub-sampling for mineral analysis. Two methods of mineral analysis were implemented. The harvest from Popayán was analyzed first with Inductive Coupling Plasma (ICP) analysis at the University of Adelaide and second with Atomic Absorption (AA) Spectrophotometry at the CIAT analytical services lab. Sample preparation for the ICP technique involved grinding 10 g of seed in a coffee mill, while for the AA technique 5 g of seed was ground in aluminum chambers using a Retsch mill and aluminum grinding balls. While replicate sampling with two repetitions each was done for the AA mineral analysis it was not possible to do this for the ICP analysis due to cost considerations.

Results and Discussion:

Iron and zinc content in the RILs presented a continuous distribution, suggesting that mineral content behaved as a quantitative trait. The range and averages for iron content was higher in Darién than in Popayán, while the zinc content range and average was lower in Darién than in Popayán (Table 1). The parents of the population showed significant differences and tended to be on the edges of the population distribution. G21242, the high mineral parent, was always higher in mineral content than G21078, the low mineral parent. In the case of iron concentration, G21078 tended to have values similar to the means of the population while G21242 was closer to the upper extreme of the population distribution, while in the case of zinc concentration the parents were more intermediate but still contrasting. Given this, transgressive segregation for low iron and for both high and low zinc was evident in the population.

Results with ICP analysis had similar population distributions as AA spectrophotometry, however G21078 was lower in iron concentration in the ICP analysis than in the AA analysis, even though G21242 was similar. For zinc, ICP values were higher than those found with AA but the population distribution was similar. AA spectro-photometry provided a savings in reagent costs and required smaller amounts of ground samples so this was the preferred method. Reliability of the AA spectrophotometric method was high with low standard deviation for parental genotypes and coefficients of variation averaging 6.8% for iron and 5.6% for zinc per genotype in the analysis of variance conducted for each location.

Genotype x environment interaction was measured for the AA results for seed iron and zinc content in a combined analysis over the two locations. Location and treatment effects were all significant at $P=0.0000$ level, showing that both genotype and $G \times E$ effects were important for both minerals, confirming the difference in the distribution and parent means discussed above. It was notable that location effects were stronger for zinc than for iron although $G \times E$ effects were similar for the two minerals. Despite the significant $G \times E$ effects, highly significant correlations were also observed between locations for both iron ($r=0.665$ under AA and $r=0.715$ with ICP) and zinc content ($r=0.439$ with AA and $r=0.450$ with ICP) irregardless of the mineral detection method. Correlations were even higher between the AA and ICP results ($r=0.849$ for iron and $r=0.860$ for zinc). Correlations were also high between iron and zinc concentration in both Darién ($r=0.301$) and Popayán ($r=0.653$ for AA and $r=0.651$ for ICP).

Table 1. Average seed iron and seed zinc content in two locations (Popayán and Darién) using atomic absorption (AA) spectrophotometry and inductive coupled plasma (ICP) analysis. Standard deviations are shown in parenthesis.

	IRON CONTENT			ZINC CONTENT		
	\bar{X} dar03AA	\bar{X} pop98AA	pop98ICP	\bar{X} dar03AA	\bar{X} pop98AA	pop98ICP
G21242	83.13 (3.09)	88.27 (4.34)	98	32.48 (1.03)	41.20 (1.49)	49
G21078	35.46	24.14 (2.39)	33	21.81	26.71 (1.77)	27
\bar{X} progeny	53.06 (13.48)	47.63 (12.03)	59.02 (12.33)	25.93 (4.29)	31.21 (5.41)	34.83 (5.35)
Range	23.14 - 99.06	22.45 - 91.34	33 - 98	13.25 - 7.66	21.02 - 9.62	25.0 - 49.0

References: Wang TL, Domoney C, Hedley CL, Casey R, Grusak MA (2003) Can We Improve the Nutritional Quality of Legume Seeds? Plant Physiology 131: 886–891.

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